

Devulcanization as a Driver of the Circular Economy in the Tire and Rubber Industry



Sam Visaisouk, *Ph.D., CEO*

visa@tyromer.com





Social Movement



Environmental sustainability, social responsibility, climate change, climate risks, circular economy... have become drivers of our economy.



BAU

- More than 1.5 billion tires hit the road this year
- They will leave the road in 3-4 years
- We will meet again to talk about scrap tires



Heavy Sea, Pejac 2014



How did we get to here?



We Need Them



They make our commerce go round and round



Easy Life of a Tire

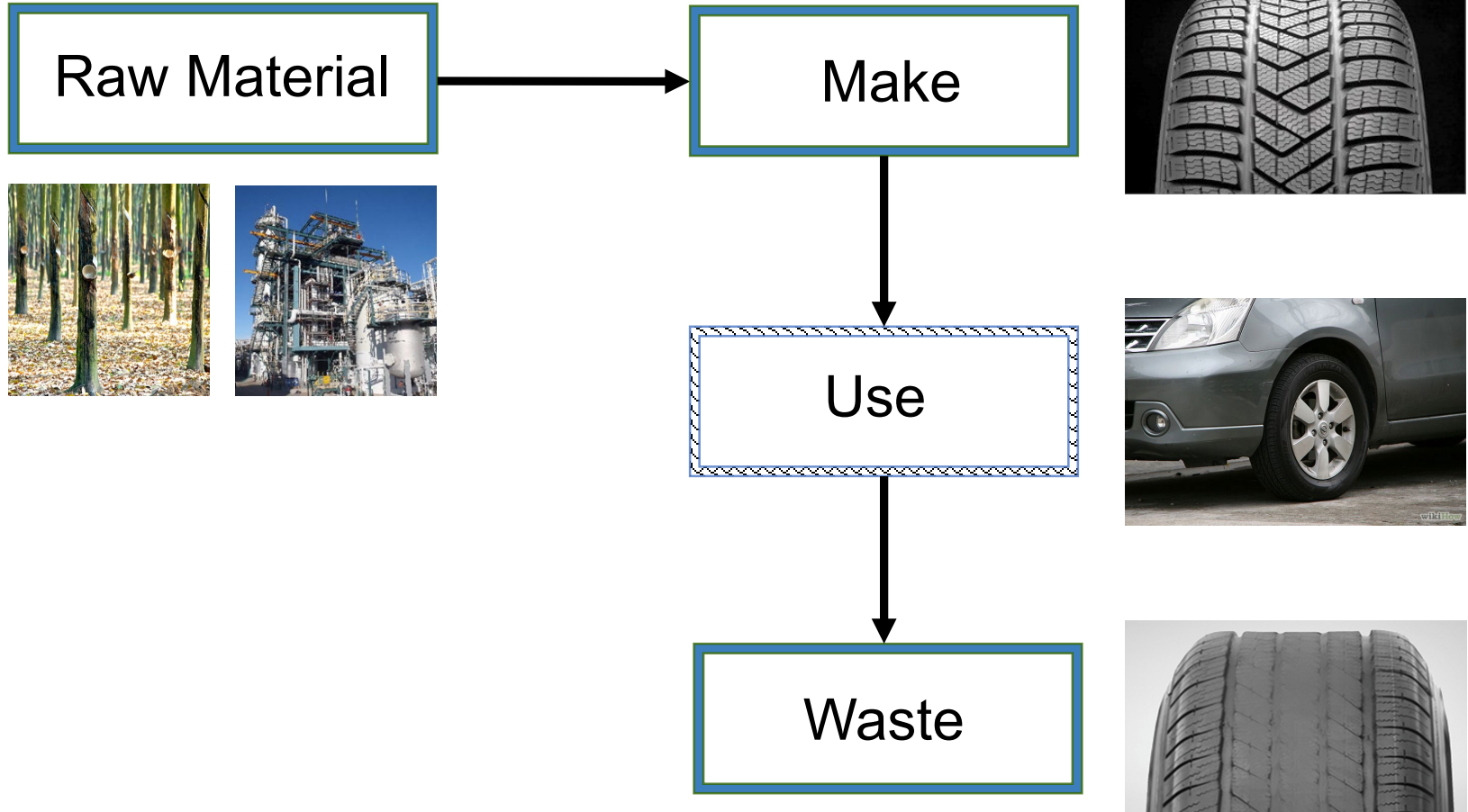


We only use about 20% of a tire.

On average, a new tire becomes a scrap tire in about 3-4 years.



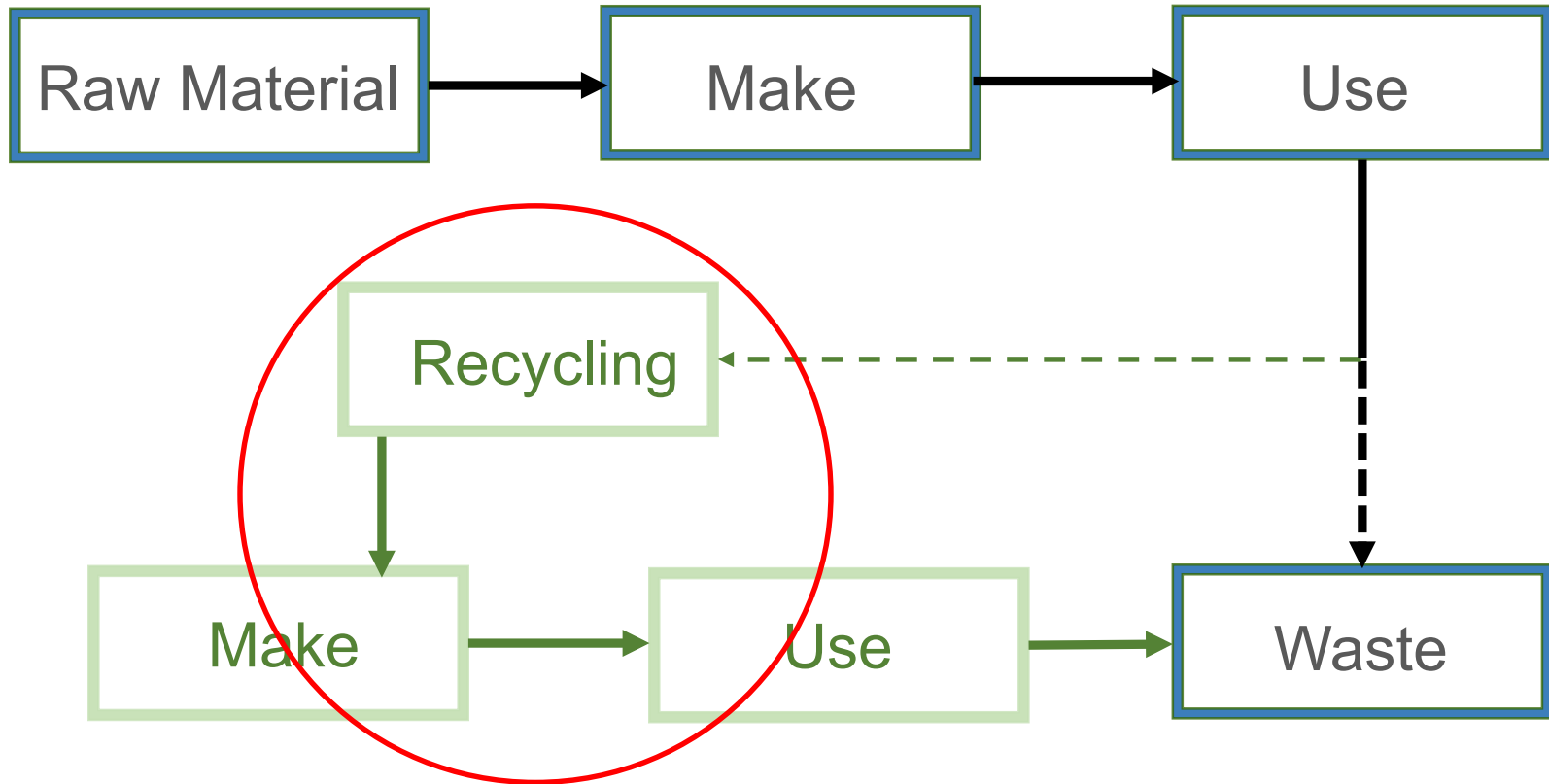
The Linear Economy



The tire industry operates in a Linear Economy in which Raw Material ends up as Waste.



Tire Recycling Today



Tire Recycling operates mainly outside the tire industry value chain.

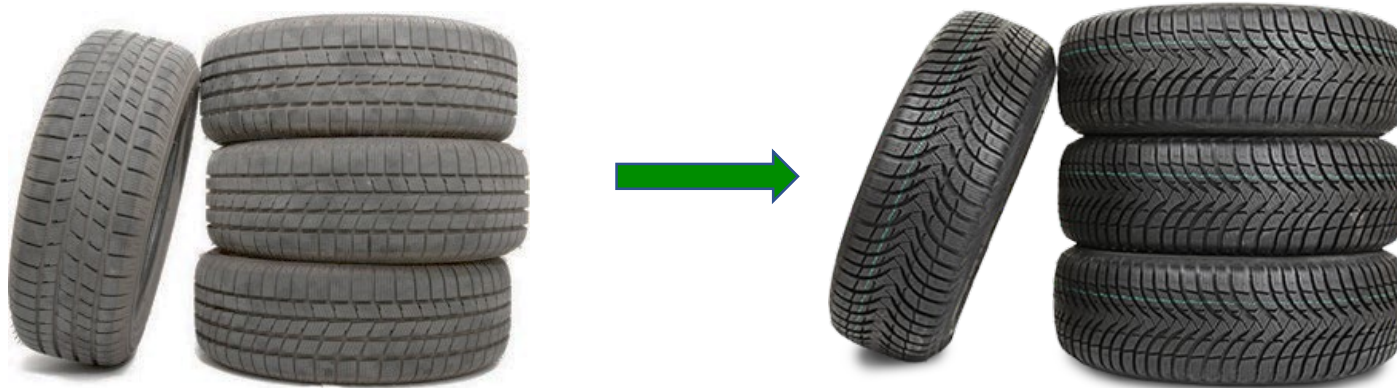


How Can We Do Better?

- Reduce the rate of scrap tire generation
- Bring recycling into the tire industry value chain
- Reduce the consumption of raw materials



Tyromer Mission



*Devulcanize scrap tire rubber
for reuse in new tires.*



The Tyromer Guiding Principle

- Collaborate with tire and rubber industry
- Produce devulcanized rubber acceptable to the tire industry on *Cost, Performance, and “Green”*



Lessons from the Past

- 1993: Ford urged MNA to test the use of recycled tire rubber.
- 1995: Michelin announced a “break through” - 10%
- 1996: Ford F-Series truck tires - 5% recycled tire rubber.
- 1998: After 5 years of development, MNA put 5% recycled rubber into OE tires on 25,000 Windstar.
- 1998: NC provided Conti General a 4Y \$1.2M grant to target 25% use of recycled tire rubber. Claims - 6% in passenger tires and 4% in light truck tires.

“We don’t want to give you the impression that MNA is using old tires from scrap piles in making any of its new tires. We don’t.”



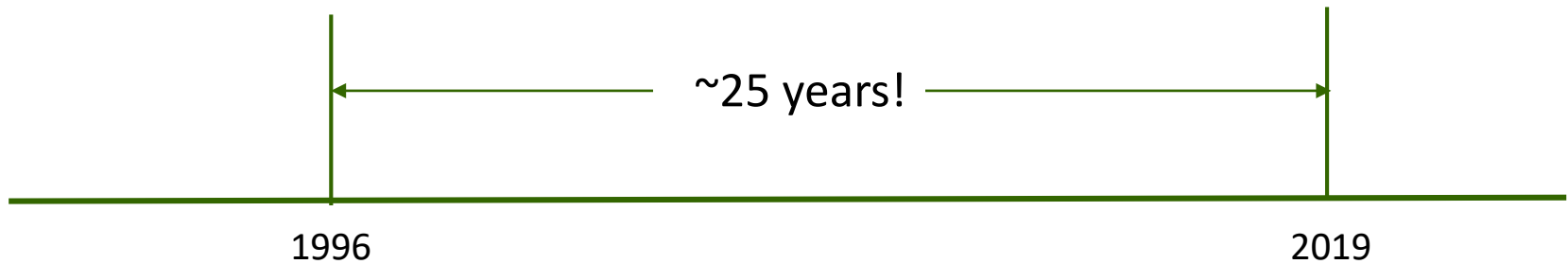
The Big picture



Ford F150:
100,000/500,000 with
~5% recycled rubber.



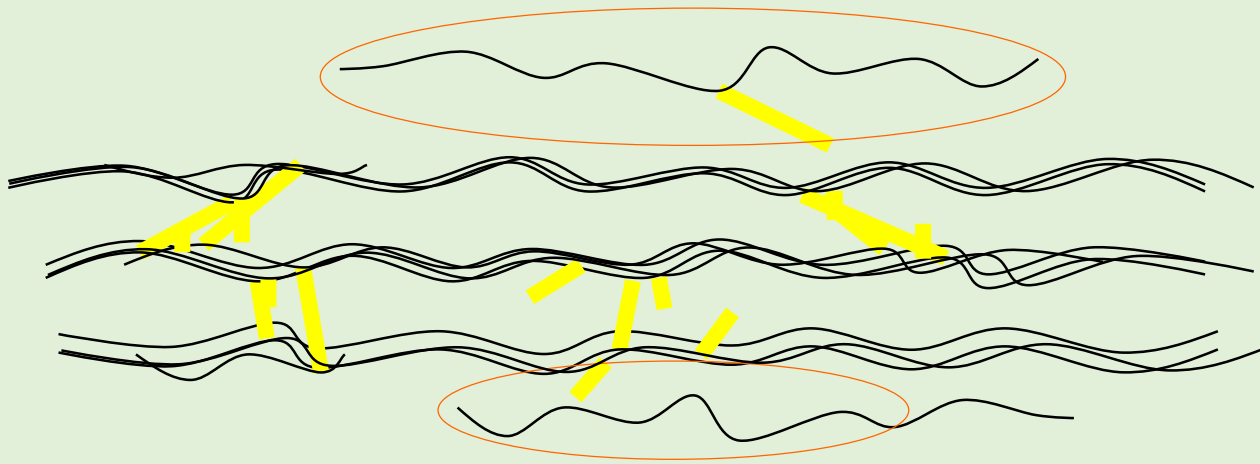
Bridgestone Ecopia: Some
contain ~5% ground-up post
consumer tires in the tread.



Why has there been so little progress?



Answer: Tire Rubber is Vulcanized



Reclaimed Rubber

- Rubber has no form or structure to be a useful material.
- Goodyear invented vulcanization to render rubber useful.
- Blessing: vulcanized rubber is versatile and durable - it fueled the Industrial Revolution.
- Curse: vulcanized rubber is too durable and cannot be easily reused.
- Holy Grail of the rubber industry: devulcanization.

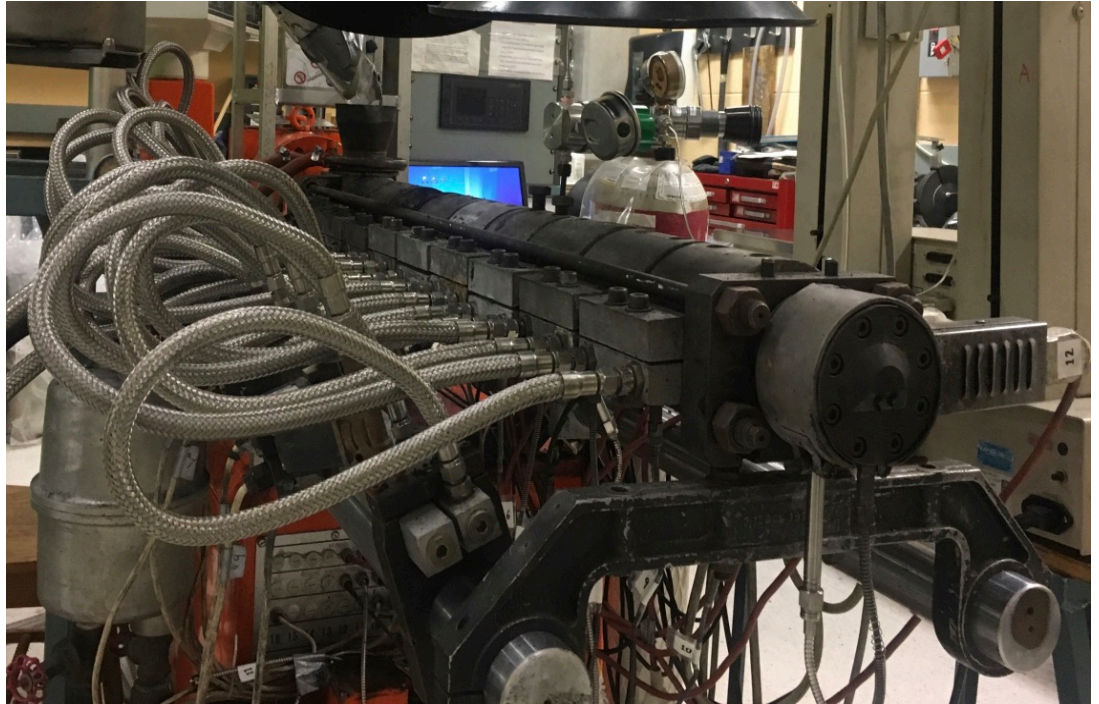


scCO₂ Reactive Extrusion



Inventor

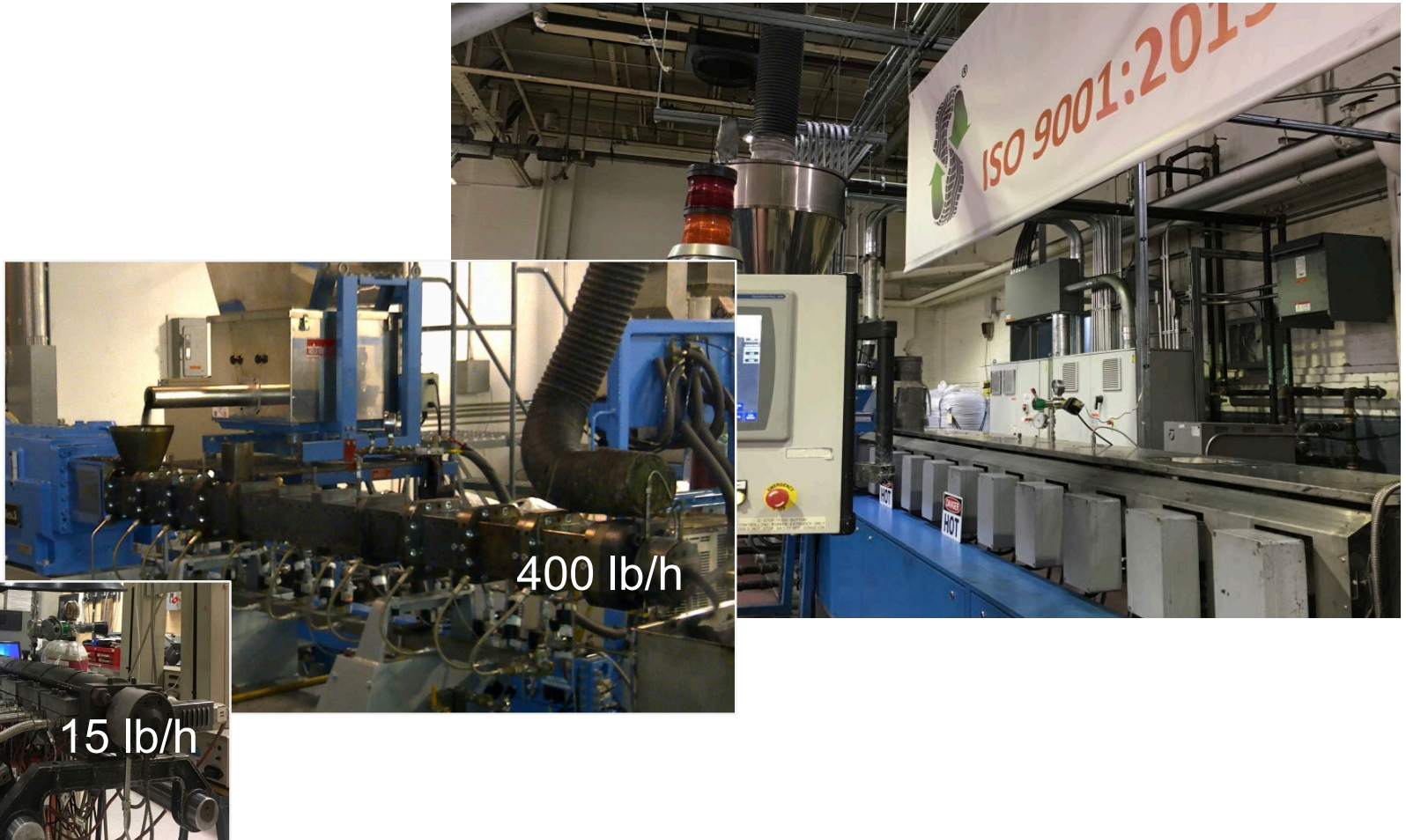
Prof. Costas Tzoganakis



Costas used inert scCO₂ as a “catalyst” and successfully devulcanize rubber in a twin-screw extruder. For the first time, rubber can be devulcanized without the use of chemical solvents and devulcanization chemicals.



Scaling the Lab Invention



Tyromer systematically scaled up the lab invention to the current 1,500⁺ lb/h continuous devulcanization.



Retreading and Sustainability

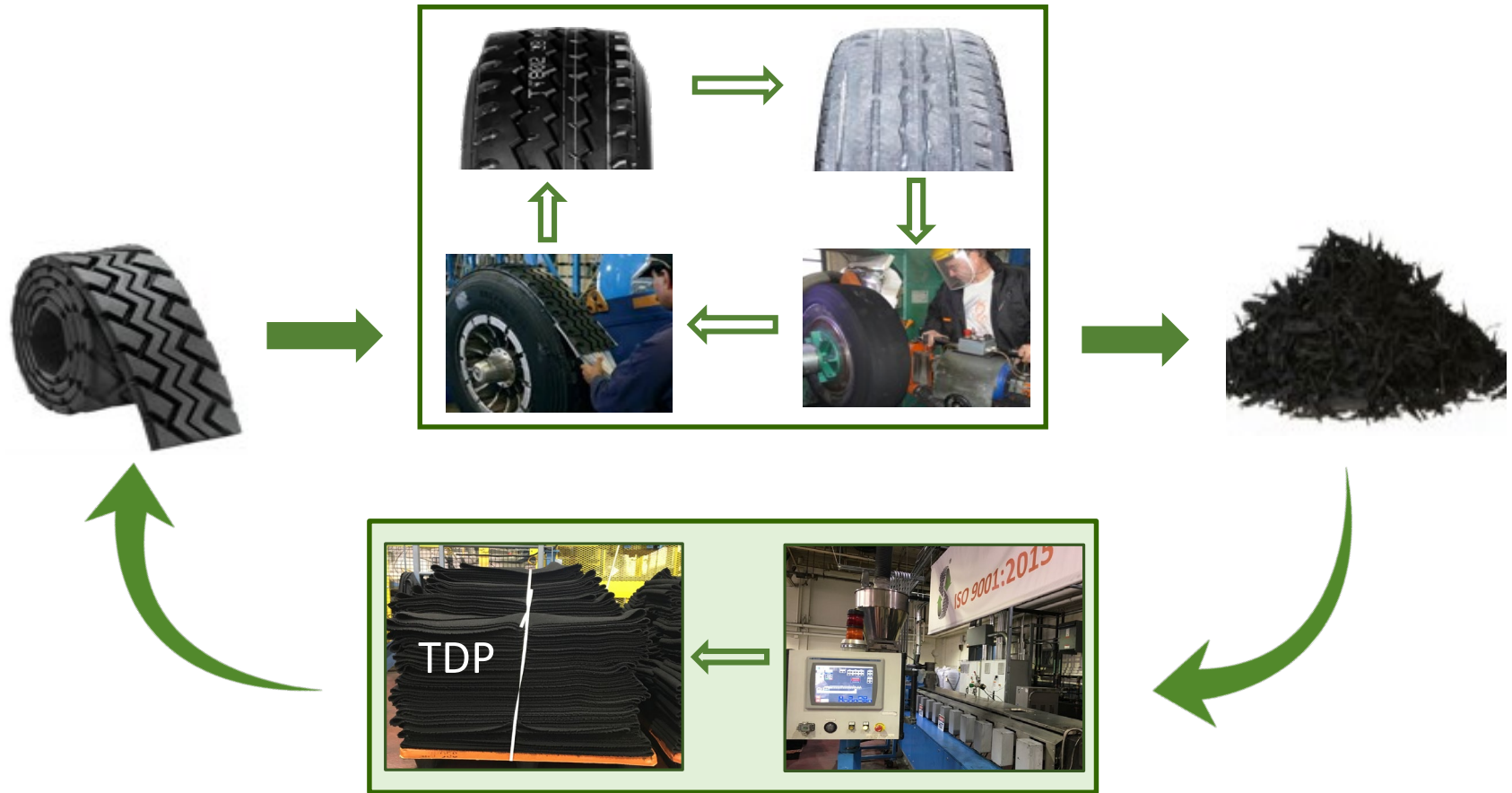


TRIB: retreading saves over 200 million gallons of oil and keeps 1.4 billion pounds of rubber out of NA landfills.

- Why are we still buying and selling single-use truck tires?
- Why don't scrap tire management agencies levy an "Environmental Burden" fee on single-use truck tires?



TDP for Circular Retreading



- Retreaders get more for their buffing waste.
- Pre-cured manufacturers get reduced material cost.



New OTR Tires

Collaboration with a global OTR manufacturer:
TDP used in new OTR tires >20%.



Agricultural Tires and Tracks



TDP is used in non-road applications.



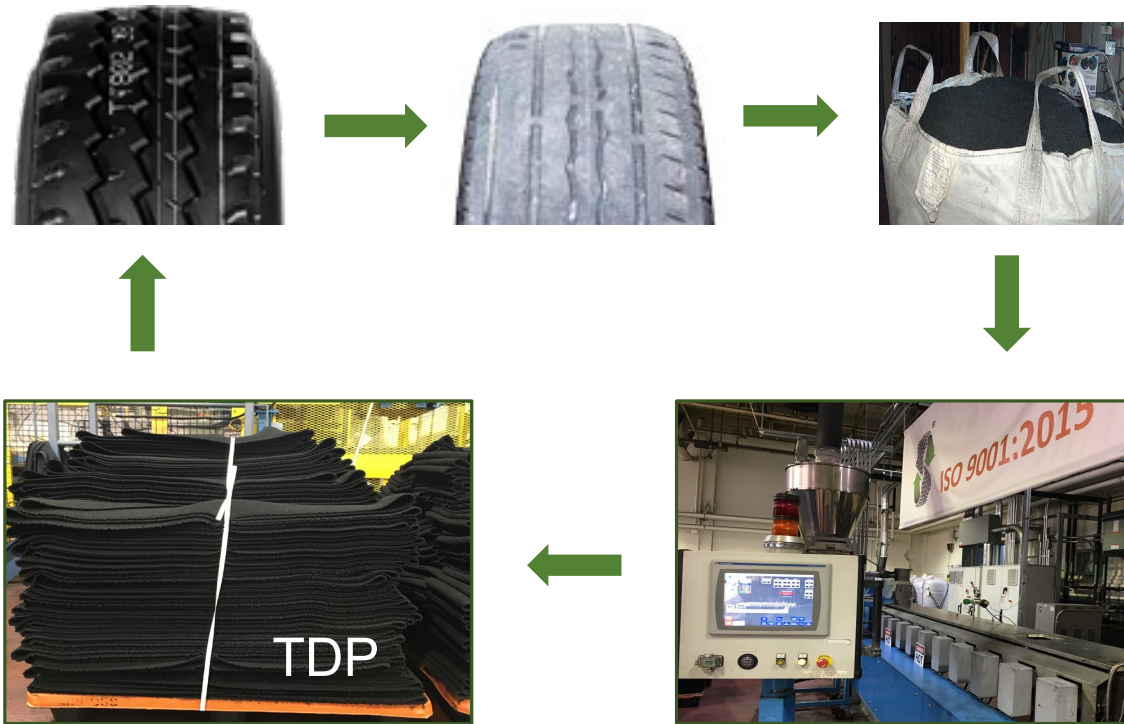
New PLT and TBR Tires



Through a collaboration with a global brand, TDP has been approved for use in PLT and TBR tires. Tyromer Windsor will have a 10,000 MT capacity.



TDP – A Circular Material for Tires



TDP offers key adoption drivers:

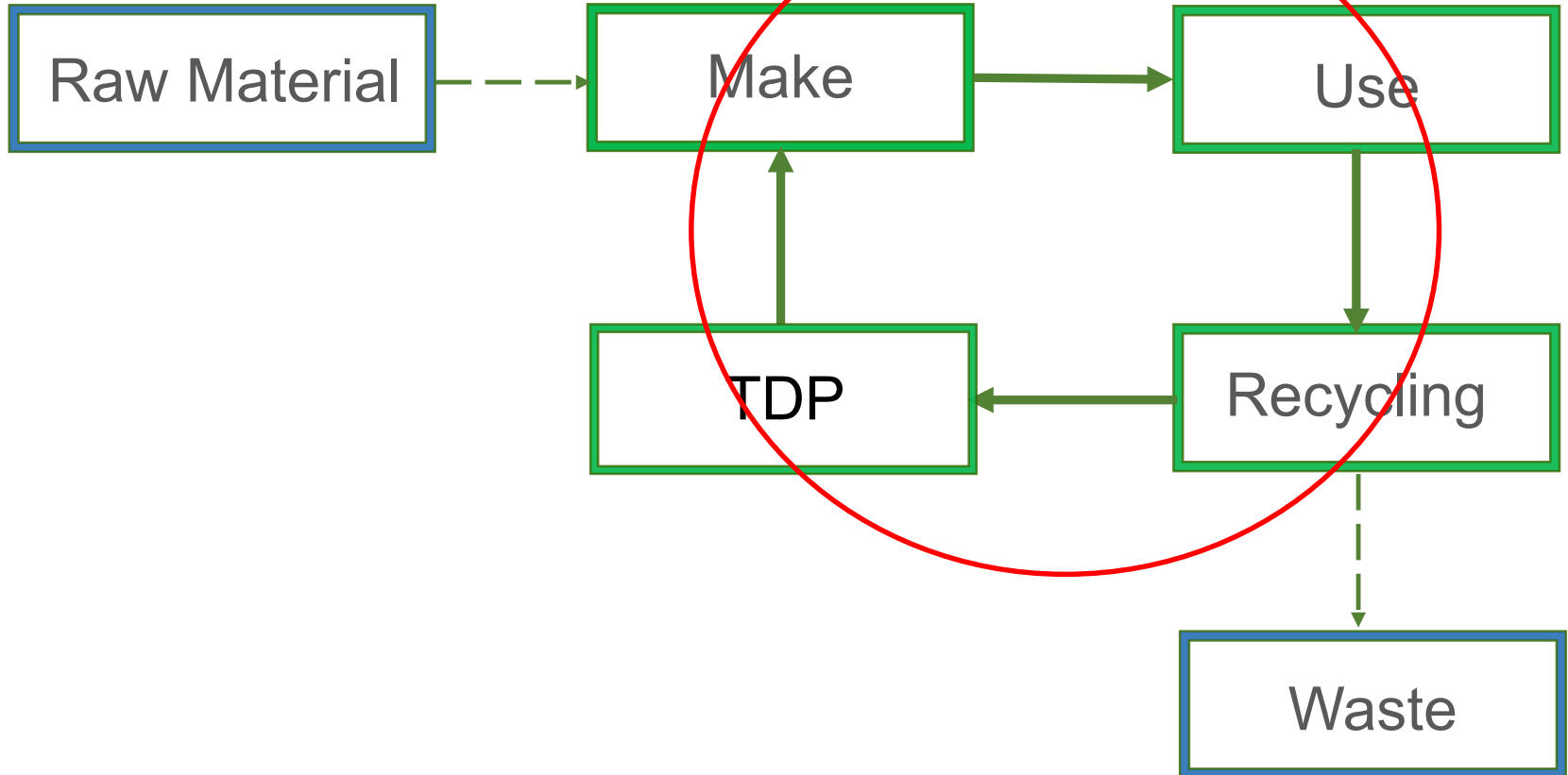
- ✓ 3. Sustainability
- ✓ 2. Performance
- ✓ 1. Low Cost

TDP: Edison Gold in the Energy & Sustainability – Resource Reuse category





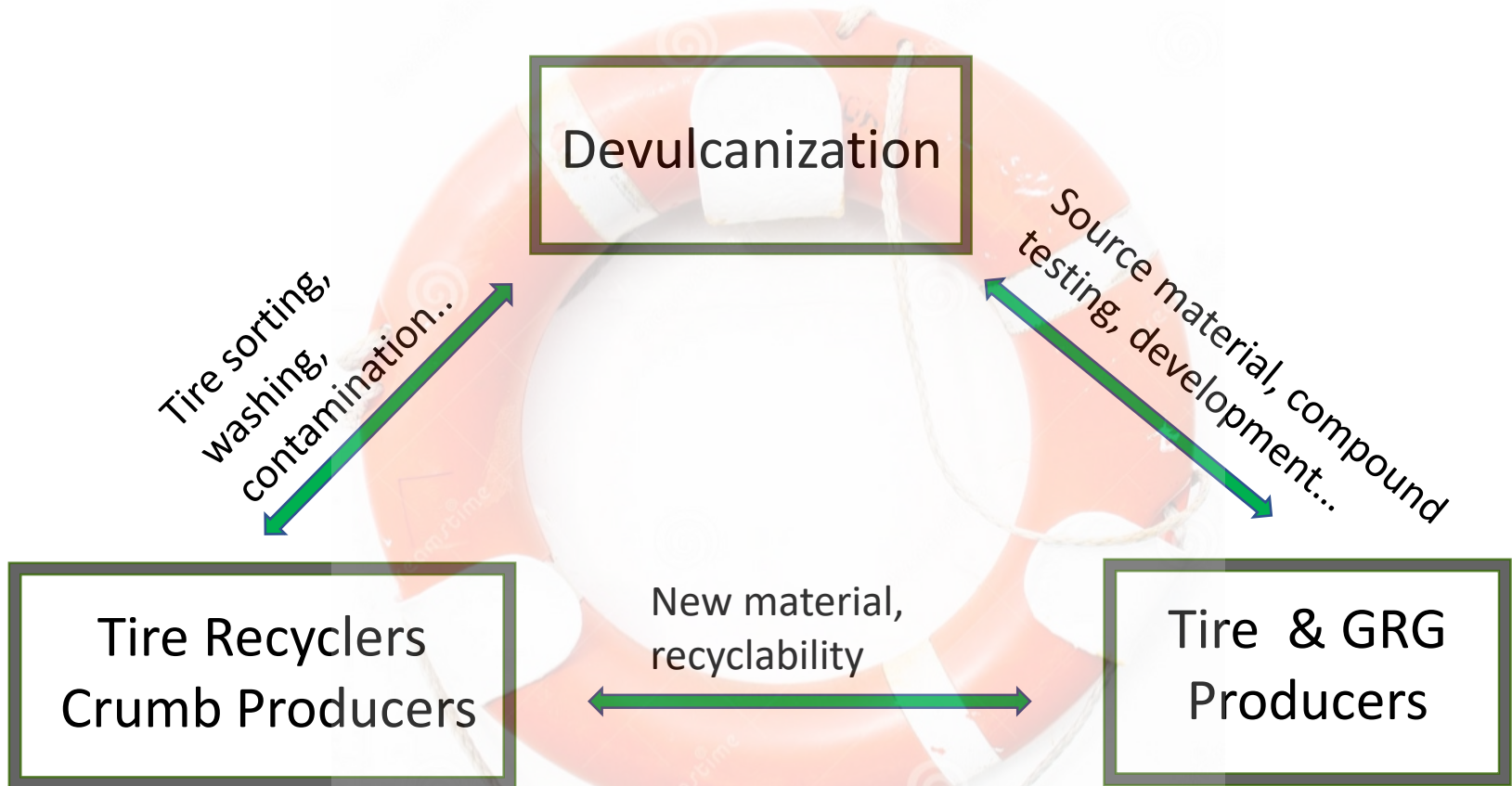
The Tire Circular Economy



TDP brings Recycling into the tire industry value chain.
In a Circular Economy, “Raw Material” is reduced.



Circular Economy Needs Collaboration



Through collaboration, three linear economies can form a circular economy.



What More Can We Ask?

We can turn a waste management nightmare into a farmer's dream: This year will bring another big crop regardless of disease, weather, flooding.....



The Tyromer Vision



In a circular economy, all new tires will contain a meaningful amount of scrap tire rubber.



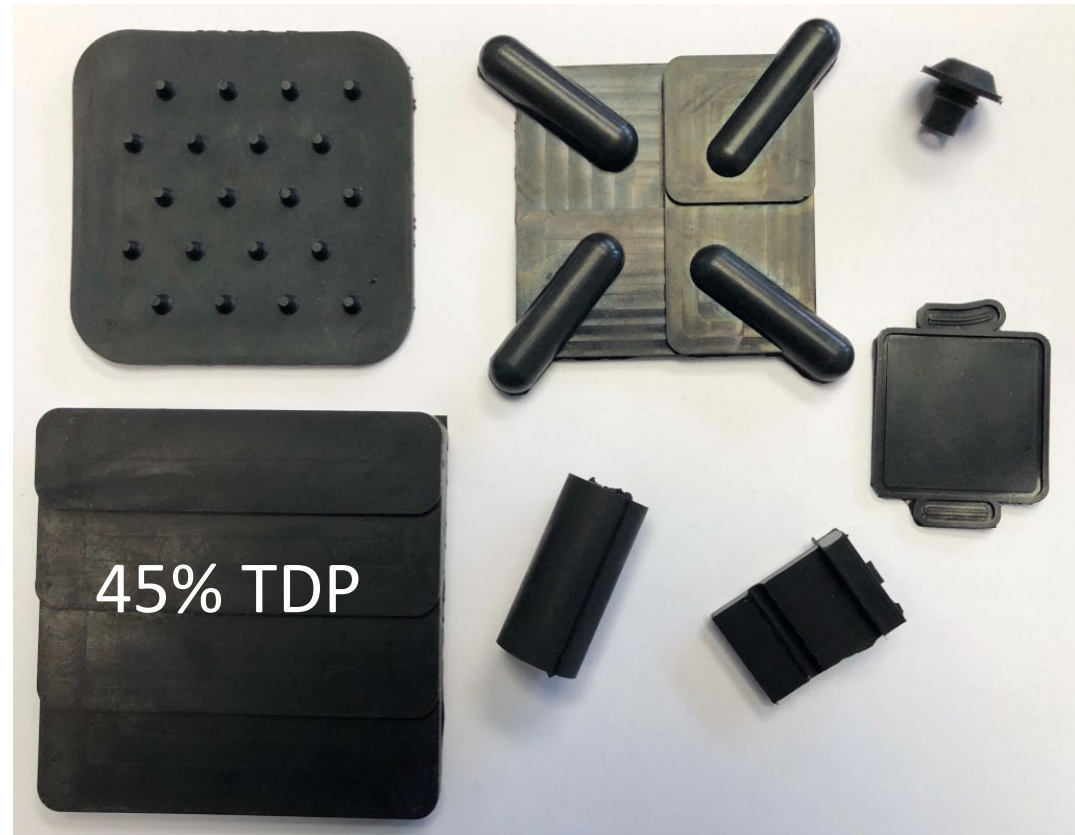
Reality Check

- Tire rubber is made from many types of rubber.
- A typical scrap tire is 4 years old; its rubber is highly degraded.
- Crumb rubber is made from all kinds of tires: truck, passenger, winter, summer, cheap, expensive, domestic, imports....

Tire rubber is an engineered material: scrap tire rubber cannot be expected to be used in new tires in high percentages.



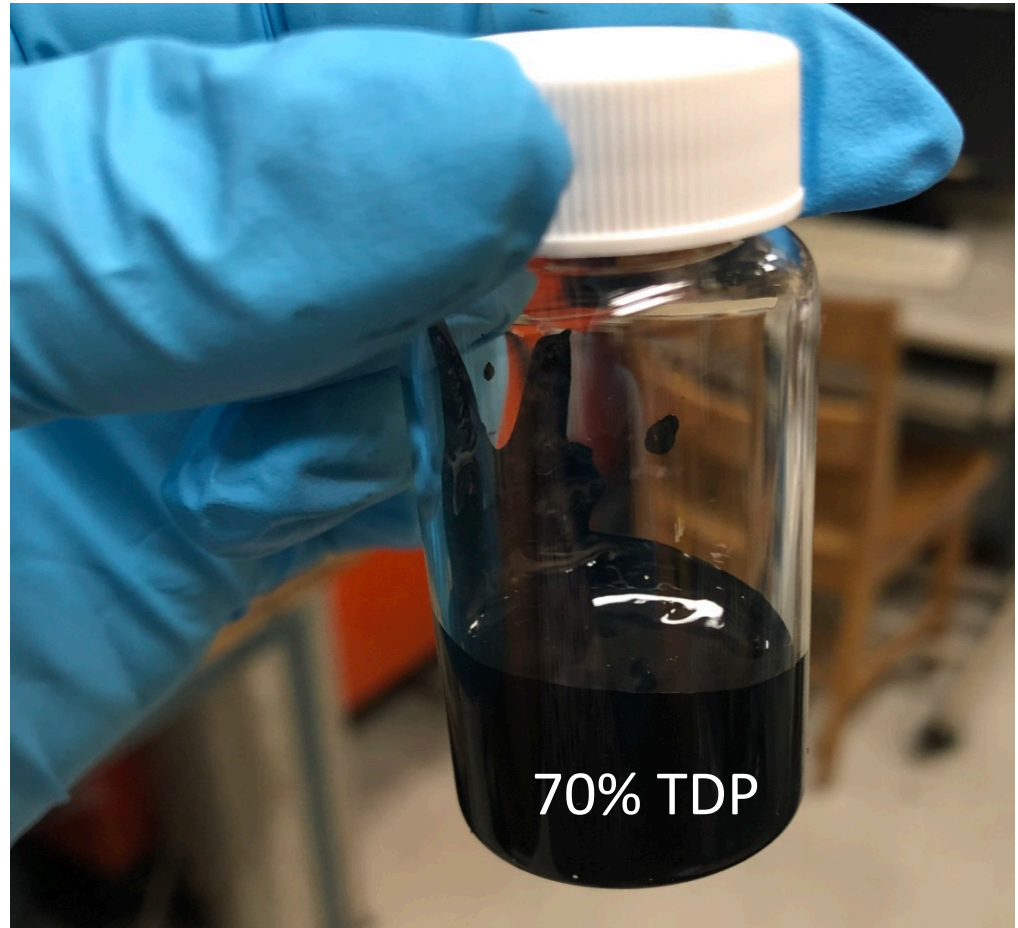
Non-Tire Markets



Akron Rubber Development Lab developed a Grade II conveyor belt compound with 20% TDP, and an automotive rubber molding compound with 45% TDP.



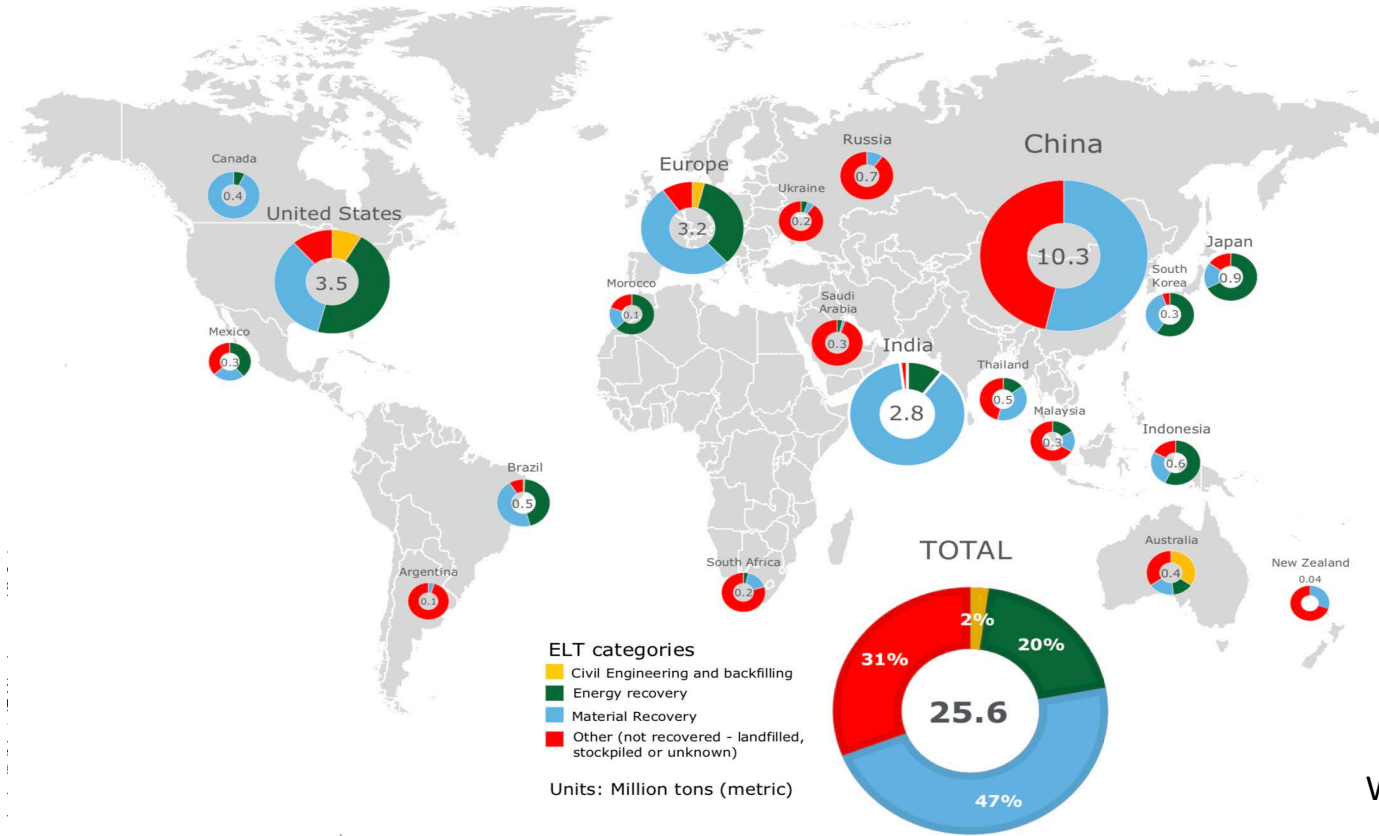
Non-Tire Market: Liquid TDP



Liquid TDP has many potential markets in the infrastructure sector such as waterproofing and road repair.



Devulcanization Is Only One Solution

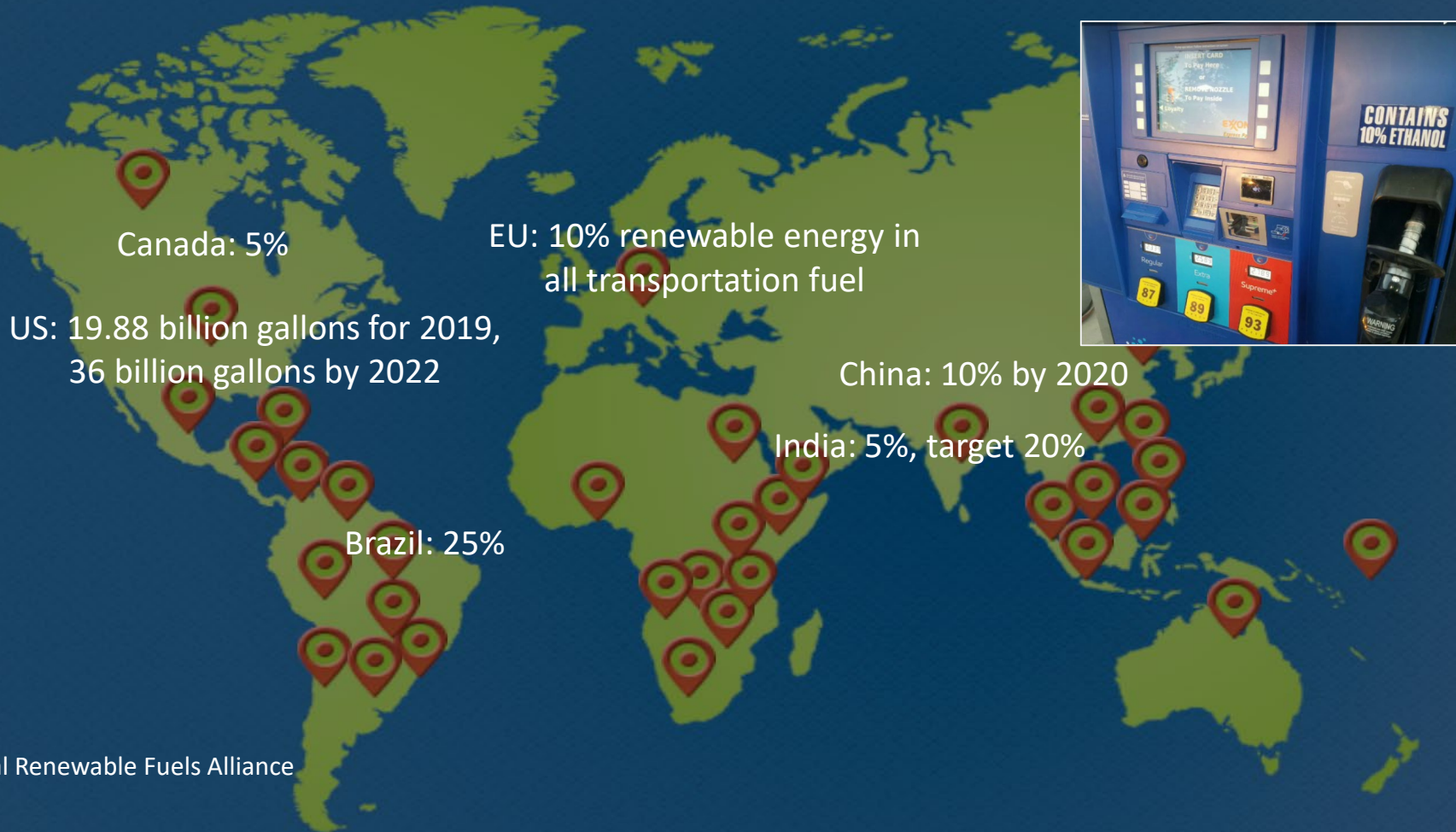


WBCSD June 2018

We need to collaborate as fellow solution providers.
Tyromer licenses of its technology and TDP
Production Systems to serve the global community.



Learn from the Renewable Fuel Movement



Global adoption of renewable fuel is a result of public policy to reduce GHG – not lower cost, not improved resource utilization...



GHG Reduction Potential

Energy Required to Produce:

New Tire Compound (kWh/kg)	26
Crumb (kWh/kg)	1.2
TDP (kWh/kg)	0.4
Energy Conserved by Using TDP vs. New Compound: 94%	

*Boustani et al, "Tire Remanufacturing and Energy Savings",
MIT Sloan School of Management, Jan 28, 2010.*

GHG Reduction Potential of Corn Ethanol vs. Gasoline: 39%

LCA of GHG Emissions from Corn-Based Ethanol; USDA 2018



Tyromer Europe BV



With support from the Netherlands Enterprise Agency, a TDP production facility will be built to showcase the CO₂ reduction potential and the Circular Economy.



What More Can We Ask?

“As the epicenter for tire manufacturing, how can South Carolina’s scrap tire program serve as an example for growing sustainable, circular markets for scrap tires?”



Please provide public policy leadership, foster collaboration and set aggressive and challenging goals for implementing the tire circular economy.